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(54) De-icing compositions for aerofoils

(57) Pastes for application to aerofoils, particularly helicopter rotor blades subjected to icing conditions with a view to preventing or reducing the formation and accretion of ice thereon in order to avoid the associated weight and aerodynamic penalties, consist essentially of a gelatin, water and glycerol mixture which includes from 3 to 20% by weight of a mineral oil having a solidification temperature of -20°C or below and from 5 to 25% by weight of a monohydric alcohol.

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**SPECIFICATION****Improvements in or relating to ice-shedding**

- 5 The problem of ice accretion on aerofoil surfaces is one of long standing and many suggestions have been made to overcome it, such as that disclosed in United States Patent Specification 2,373,727 of applying to appropriate parts of the aircraft a deicing composition consisting of gelatinous material and glycol, or glycerol, or homologues thereof, or polyglycols, or polyglycerols, eg diethylene glycol, or triethylene glycol, or mixtures thereof containing a proportion from 5-20% by weight of a liquid which is immiscible with ice or 10 water and which remains liquid down to 10°F (-12.2°C). Additionally the composition may also include a proportion of a water soluble monohydric alcohol such as ethyl alcohol.

Forces are generated on helicopter rotor blades which are considerably in excess of those on conventional aerofoil surfaces and tests have shown that the ingredients of deicing pastes must be carefully chosen to ensure that they have adequate adhesion to the rotor blade to withstand the forces generated by rotation.

- 15 In accordance with the present invention a composition for application to a helicopter rotor blade to prevent or inhibit the accretion of ice thereon consists essentially of a gelatin, water and glycerol mixture which includes from 3 to 20% by weight of a mineral oil having a solidification temperature of -20°C or below and from 5 to 25% by weight of monohydric alcohol preferably propan-2-ol, and wherein the gelatin used to produce the mixture has a Bloom value of at least 150, and preferably in the region of 200 if produced by a 20 lime process and of at least 200, and preferably in the region of 250 is produced by an acid process.

The Bloom number of a gelatin is a standard test of its stiffness and a Bloom value of 250 is about the greatest value normally obtained. It has been found that gelatins produced by a lime process tend to be more viscous than a gelatin of the same Bloom number produced by an acid process and accordingly pastes having about the same adhesion can be produced by using gelatin from an acid process with a Bloom 25 number about 50 greater than a gelatin produced by a lime process. Pastes produced from the gelatin with the highest Bloom number, ie the most viscous pastes, may be applied by brushing; but it may be necessary to employ less viscous pastes if they are to be applied by spraying.

It has been found essential to include glycerol, rather than glycol, in order to provide sufficient adhesion for the paste to the substrate and also to include a proportion of monohydric alcohol in order to reduce the 30 viscosity of the composition to manageable values. The reduction in viscosity required for spraying as mentioned above may be achieved by using an increased proportion of monohydric alcohol. In general a soap or detergent, or similar material, is necessary in small proportion to assist the dispersal of the oil and a foam suppressant, for example amyl alcohol, also in small proportion, to reduce frothing caused by the viscous nature of the composition.

35 Preferred pastes of the present invention fall within the composition of 8.0 to 12.0% by weight of gelatin having a Bloom number of 200 if produced by a lime process or a Bloom value of 250 if produced by an acid process, 15 to 20% by weight of water, 45 to 55% by weight of glycerol, 5 to 20% by weight of propan-2-ol, 5 to 12% by weight of water immiscible oil, up to 0.5% by weight of a detergent and 0.1% by weight of a foam suppressant.

40 Deicing pastes of the present invention are particularly useful when employed in conjunction with heating of the leading edge of a helicopter rotor blade as disclosed in copending Patent Application No. 26429/77.

The invention will now be described and illustrated by way of example only.

The adhesion of the pastes was tested in the following manner. A layer of paste about 1 mm thick was applied to a flat clean aluminium plate or polyurethane-covered aluminium plate measuring about 150 × 150 45 × 2mm. A woven cotton strip, 25mm wide and 200mm long was placed on the paste before it dried and more paste applied over the cotton so that it was embedded in the coating leaving a free end about 50mm long. The paste was allowed to harden (normally one hour) and knife cuts were made through the paste to the substrate along the long edges of the cotton. A spring balance was hooked through a hole in the free end of the cotton and the cotton reinforced paste was peeled from the substrate at right angles at about 100mm/min 50 and the average failing load (in grams) noted.

**EXAMPLE 1**

A series of pastes were prepared containing 6 parts by weight of gelatin, 10 parts by weight of water and 29 parts by weight of ethylene glycol or glycerol together with other ingredients as set forth in the Table below.

Table 1 below indicates the varieties of gelatin used, the proportions by weight of other ingredients and 55 also the average peel strength in grams at 20°C on polyurethane 1 hour after application.

TABLE 1

Sample Number	Gelatin Type	Additional Component parts by weight		Peel Strength
		Propan-2-ol	Oil OM 33 + teepol	
1	Bloom 150 (limed)	—	—	110
2	Bloom 150 (acid)	—	—	40
3	Bloom 200 (limed)	—	—	25
4	Bloom 200 (acid)	—	—	25
5	Bloom 250 (limed)	—	—	20
6	Bloom 250 (acid)	—	—	30
7	Bloom 150 (limed)	4	—	250
8	Bloom 200 (limed)	5	—	150
9	Bloom 250 (limed)	—	—	120
10	Bloom 50 (limed)	11	5	75
11	Bloom 100 (limed)	11	5	110
12	Bloom 110 (acid)	11	5	85
13	Bloom 150 (limed)	11	5	233
14	Bloom 150 (acid)	11	5	192
15	Bloom 200 (limed)	11	5	267
16	Bloom 200 (acid)	11	5	133
17	Bloom 250 (limed)	11	5	250
18	Bloom 250 (acid)	11	5	210
19	Bloom 200 (limed)	11	9	120
20	Bloom 200 (limed)	32	5	200

It will be appreciated that the compositions reported in the Table above can be readily converted to % by weight.

Pastes number 1 to 6 include ethylene glycol, the remainder glycerol, and the effect of this is clear from the peel strength values, irrespective of the type of gelatin used. Paste number 9 differs from paste number 5

5 only in the substitution of glycerol for lycol and the strength figure varies by a factor of 6. Pastes 7 and 8 show the advantage of including propan-2-ol when compared with paste 9.

Pastes 10 to 18 illustrate the effect of type of getalin upon adhesion of a paste including propan-2-ol and a mineral oil. It will be noted that the adhesion increases as the Bloom number increases and also that for the same Bloom number a limed gelatin, that is one produced by a lime process, has greater adhesion than an acid one.

10 Although pastes with a Bloom number of 150, eg 13 and 14 have good peel adhesions, practical tests have shown that they readily lose adhesion when subjected to repeated formation of ice.

Comparison between paste number 15 and paste number 19 illustrates that increasing the oil content reduces adhesion and between paste number 15 and 20 illustrates that increasing the proportion of propan-2-ol decreases the adhesion although the effect is not serious.

**EXAMPLE 2**

- 5 With the information set forth in Example 1 in mind the paste compositions set forth in Table 2 below were prepared.

TABLE 2

	COMPONENT	COMPOSITION			10	
		% BY WEIGHT				
		A	B	C		
15	Gelatin, Bloom 200 (limed)	9.8	10.3	10.9	15	
	Water	16.3	17.2	18.1		
	Glycerol	47.3	49.8	52.5		
	Propan-2-ol	18.0	18.9	9.0		
	Oil OM 33	8.2	3.4	9.0		
	Teepol	0.3	0.3	0.4		
20	Amyl alcohol	0.1	0.1	0.1	20	

The paste compositions are applied by warming in hot water until they become liquid and then brushing on the appropriate parts.

In a practical test composition A was applied to the outer 50% of span of the rotor blades of a helicopter, 25 which was then flown in clear air without deleterious effect on the aerodynamic and handling characteristics 25 of the aircraft as shown by monitoring of the pitch link loads.

**CLAIMS**

- 30 1. A composition for application to a helicopter rotor blade to prevent or inhibit the accretion of ice 30 thereon consisting essentially of a gelatin, water and glycerol mixture which includes from 3 to 20% by weight of mineral oil having a solidification temperature of -20°C or below and from 5 to 20% by weight of a monohydric alcohol and wherein the gelatin used to produce the mixture has a Bloom value of at least 150 is produced by a lime process and a Bloom value of at least 200 if produced by an acid process.
- 35 2. A composition as claimed in claim 1 and wherein the monohydric alcohol is propan-2-ol. 35
3. A composition as claimed in claim 1 or claim 2 which includes a small proportion of soap or detergent.
4. A composition as claimed in claim 1, 2 or 3 which includes a foam suppressant.
5. A composition as claimed in any one preceding claim which includes between 8 and 12% by weight of gelatin producing by a lime process and having a Bloom value of 200, between 15 and 20% by weight of 40 water, between 45 and 55% by weight of glycerol, between 5 and 20% by weight of propan-2-ol, between 5 and 12% of water immiscible oil, up to 0.5% by weight of a detergent and approximately 0.1% by weight of a 40 foam suppressant. 40
- 45 6. A composition as claimed in any one of claims 1 to 4 which includes between 8 and 12% by weight of gelatin produced by an acid process and having a Bloom value of 250, between 15 and 20% by weight of water, between 45 and 55% by weight of glycerol, between 5 and 20% by weight of propan-2-ol, between 5 and 12% of water immiscible oil, up to 0.5% by weight of a detergent and approximately 0.1% by weight of a 45 foam suppressant. 45
7. A composition as claimed in any one preceding claim substantially in accordance with composition A, B or C of Table 2 above.

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